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On an Instance of Change of Personality in Observing Position Angles of Double Stars; and on the Orbit of α Centauri. By A. M. W. Downing, M.A.

In vol. xlvii. of the *Memoirs* of this Society there is a paper by Mr. H. C. Russell containing observations of double stars made at the Sydney Observatory during the years 1870–1881. In this paper will be found a considerable number of observations of *α Centauri*, some of the earlier of which have been used by Dr. Elkin in the determination of the orbit of this binary star contained in his valuable paper, *Ueber die Parallaxe von α Centauri*. But a good many of the Sydney observations made since 1877·5 have not been used in Dr. Elkin's investigation; and these, together with some recent measures by M. Hall, Ellery, and Tebbutt, are available for determining corrections to Elkin's elements in order to obtain an orbit which shall represent the later as well as the earlier observations.

With this object in view the necessary calculations were made, and it was found that, in the mean, the position angles computed from Elkin's elements required corrections of $-7\frac{1}{2}^\circ$ in 1878, and of $-3\frac{1}{4}^\circ$ in 1879–81, to make them agree with the observed position angles. An attempt was then made to modify Elkin's elements so as to make them represent the series of observed angles. After working at the subject for some time, however, I convinced myself that these corrections were erroneous, as I was unable to construct an ellipse which would satisfy the earlier as well as the later measures. As it was the introduction of the Sydney observations made after 1878·0 which caused the great discordance between the computed and observed angles, I determined to exclude them, and then found that the requisite corrections became −1°·14 in 1878 and −1°·26 in 1879–81. It was evident, then, that the corrections to the assumed elements would be quite small, and I proceeded to find them in the manner now to be described.

From a consideration of the outstanding errors of position angles computed from the assumed elements, the following seven normal places were formed (the angles being measured from the circle of declination passing through the principal star at 1860·0):—

	Epoch.	Normal Angle.	Computed Angle.	Normal Distance.	Computed Distance.
		°	°	″	″
(1)	1827·530	213·34	213·27		
(2)	1835·997	219·34	218·81	16·84	16·69
(3)	1852·177	258·76	258·96	5·50	5·40
(4)	1858·745	335·05	335·12	4·69	4·85
(5)	1875·455	36·61	36·61	5·97	5·92
(6)	1878·380	139·23	139·01	1·96	1·85
(7)	1880·361	187·44	187·70	5·32	5·51

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Seven equations of condition were then formed, by means of the usual formula, for the determination of corrections to T, P, and e, and solved by the method of least squares, and from the new values of these elements and Elkin's values of λ, γ, and ☊, position angles corresponding to the last six epochs were computed, and from the differences between these and the normal values, and from differential coefficients formed by varying λ, γ, and ☊, equations of condition for determining corrections to these elements were formed, and hence the required corrections found by the method of least squares. The position angles computed from the new elements are given in the column headed "Computed Angle." A correction to Elkin's value of the semi-axis major was then found from the new values of the other elements in conjunction with the normal distances, allowing half weight to the normal distance corresponding to 1878·380. The elements thus found are as follows:—

T	1875·951
P	76·222 years
e	0·51578
λ	54° 59′·2 (1860·0)
γ	79 15·2
☊	25 30·5
a	17″·33

A detailed comparison of places computed from these elements with the observations made since 1870 is given at the end of this paper. This comparison shows that up to the end of 1877 the Sydney measures of position angles agree, within the limits of error of the observations, with those of other observers, but that in 1878 a remarkable change in the manner of observing occurred, which is continued, though in a less degree, in 1880. This change, which makes Mr. Russell's measures in 1878 (of which there are a considerable number) differ by 5 or 6 degrees from the average of other observers, may perhaps be connected with the change of direction of the line joining the components; the *comes* having passed from the n.f. to the s.f. quadrant towards the end of 1877. It is a useful illustration of one of the many difficulties which beset those who are engaged in investigating the orbits of double stars.

The observed position angles or distances enclosed within brackets in the following table have not been used in determining the elements given above: those measured by Mr. Powell because they were not published at the time when the normal places were formed; the others because of their discordance. It is evident that, thanks to Dr. Elkin's able and thorough investigation, we are now in possession of elements of *α Centauri* which will probably require but small correction in order that they may represent observations made in the future. The corrections deduced in the present paper are of course not entitled to much

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weight, as they depend on but few observations; and the subject has been brought forward chiefly with the view of calling attention to the change in the method of observing referred to above.

Epoch.	Observer.	θ_o	$\theta_o - \theta_c$	ρ_o	$\rho_o - \rho_c$
		°	°	″	″
1870·100	Powell	20·45	−0·11	10·24	+0·07
70·608	”	(21·80)	+0·21	(10·09)	−0·48
70·746	Russell	22·32	+0·42	10·46	−0·08
71·050	Powell	(23·01)	+0·52	(9·89)	−0·68
71·310	”	(23·70)	+0·67	(9·80)	−0·59
71·473	Russell	22·91	−0·46	10·23	−0·11
72·468	”	25·33	−0·24	9·73	−0·04
73·331	”	28·07	+0·27	9·50	+0·50
74·150	Ellery	30·50	+0·15	8·00	−0·01
74·468	Russell	30·00	−1·55	7·97	+0·42
74·850	Lindsay	34·17	+0·99		
75·020	Seeliger	34·21	+0·20	6·82	+0·14
76·411	Russell	46·97	+1·52	4·35	+0·27
76·615	Ellery	51·05	+2·55	4·15	+0·47
76·940	”	51·20	−3·87		
77·140	M. Hall	64·40	+3·77	3·30	+0·62
77·248	Ellery	(69·10)	+4·80		
77·510	Russell	72·78	−3·07		
77·556	”	77·25	−1·10	2·11	+0·09
77·580	Gill	80·50	+0·81		
77·593	Russell	81·74	+1·30	1·90	−0·07
77·629	Gill	81·52	−1·08		
77·834	”	97·14	+0·49		
77·888	”	101·04	+0·26		
78·153	Russell	(116·11)	−6·07	1·77	+0·08
78·225	”	(121·66)	−6·11	1·98	+0·26
78·279	”	(127·37)	−4·44	1·77	+0·01
78·380	M. Hall	139·10	+0·22	2·40	+0·55
79·252	Ellery	174·40	+0·83	3·41	+0·14
79·474	Hargrave	(173·55)	−4·17	3·41	−0·30
80·186	Tebbutt	186·70	+0·53	4·97	−0·19
80·351	”	186·40	−1·08	5·31	−0·18
80·444	Russell	(184·98)	−3·18	5·32	−0·36
81·279	Hargrave	(189·88)	−2·81	(5·07)	−2·25
81·545	”	(190·13)	−3·61	7·52	−0·31
1881·655	Tebbutt	193·15	−0·99	7·95	−0·09

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Note on the Determination of the Planes of the Orbits of Jupiter's Satellites. By A. Marth.

The values of the nodes and inclinations of the orbits of *Jupiter's* satellites which are derived from observed eclipses are liable to a very sensible amount of uncertainty. The eclipses of longest duration give, indeed, the places of the nodes on *Jupiter's* orbit, while those of shortest duration furnish the inclinations. But as the eclipses which occur near the nodes vary little in duration, the ordinary errors of the observations, and, still more, the usual want of observations of successive eclipses at the proper epochs, leave considerable uncertainty in fixing the places of the nodes; and, in the case of the eclipses of shortest duration, if they occur far from the centre, an additional difficulty arises from the uncertainty of the real extent of the sections of the shadow by which the eclipses are produced.

So long as the observations of eclipses were the only trustworthy means available for finding not only the longitudes of the satellites in their orbits, but also the positions of their orbits, the ensuing uncertainty had to be submitted to as unavoidable. But since superior instruments and micrometers have become available, advantage ought to have been taken and ought to be taken to employ them at the proper times for the purpose of procuring those elements which cannot be derived from eclipse observations with the same degree of accuracy. As the apparent motion of the satellites at the beginning and end of nearly central eclipses amounts, during one minute of time, for

Sat. I., II., III., IV.,
to 0″·36, 0″·29, 0″·23, 0″·17,

when *Jupiter* is nearest to the Earth, or when *Jupiter* is at its mean distance to

0″·27, 0″·22, 0″·17, 0″·13,

it is easily seen that for determining the longitudes of the satellites in their orbits, micrometrical measurements are not likely to supersede in accuracy trustworthy observations of the times of eclipses, at least when the satellites do not pass too far from the centre of the shadow cone. But the case is different with regard to the determination of the planes of the orbits, especially the fixing of the nodes.

The most promising means for determining the longitudes of the nodes with accuracy will be found in micrometrical measurements of the distances at which the shadows of the satellites near their mid-transits appear from the centre line which bisects *Jupiter's* disc perpendicular to the axis of rotation, if these measurements are made about the times when the planes of the orbits pass through the Sun. That is the case in the present